SPH4UR WS-4

#1

ACCEL. | UNIF. VEL. | ACCEL. $\oplus\rightarrow$

$\vec{v}_1 = 0\,m/s$ $\quad t = 12\,s$ $\quad \Delta\vec{d} = 100\,m$

$\vec{a} = 4.0\,m/s^2$ $\quad \vec{v}_2 = 0\,m/s$

$t = 10\,s$

$\vec{v}_{avg} = \dfrac{\Delta\vec{d}}{\Delta t}$ ← NEED TOTAL DISP. / ← NEED TOTAL TIME

$\Delta\vec{d} = \vec{v}_1\Delta t + \frac{1}{2}a\Delta t^2$

$= 200\,m$

$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$
$= 40\,m/s$

NEED $\vec{v} = \vec{v}_2$ FROM FIRST PART

$\Delta\vec{d} = \vec{v}\Delta t$
$= 40(12)$
$= 480\,m$

$\vec{v}_1 = \vec{v}_0$ FROM PART TWO

$\Delta\vec{d} = \left(\dfrac{\vec{v}_1 + \vec{v}_2}{2}\right)\Delta t$

$100 = \left(\dfrac{40+0}{2}\right)\Delta t$

$\Delta t = 5.0\,s$

TOTAL $\Delta\vec{d} = 780\,m$ [fwd]
TOTAL $\Delta t = 27\,s$

$\vec{v} = \dfrac{\Delta\vec{d}}{\Delta t} = 28.9\,m/s$ [fwd]

$\doteq 29\,m/s$ [fwd]

#2

IGOR ←— 8.0m —→ BRIAN ←— x —→

UNIF. $\quad$ ACCEL.

$\oplus\rightarrow$

$\vec{v}_1 = 7.0\,m/s$ [E]

BRIAN
$\vec{v}_1 = 0\,m/s$
$\vec{a} = 2.8\,m/s^2$ [E]

- IN THIS SCENARIO, IGOR RUNS $\Delta d = 8 + x$ WHILE BRIAN RUNS $\Delta d = x$.
- THE TIME ELAPSED IS THE SAME FOR BOTH.

$\Delta\vec{d} = 8 + x$
$\Delta t = y$

$\Delta\vec{d} = \vec{v}\Delta t$

$8 + x = 7y$ ①

$\Delta\vec{d} = \vec{v}_1 t + \frac{1}{2}\vec{a}\Delta t^2$

$x = 0 + 1.4y^2$ ②

SUB ② INTO ①

$\therefore 8 + 1.4y^2 = 7y$

$1.4y^2 - 7y + 8 = 0$

SOLVE QUADRATIC

$y = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$= \dfrac{7 \pm \sqrt{49 - 4(1.4)(8)}}{2(1.4)}$

$= \dfrac{7 \pm 2.05}{2.8}$ $\quad \therefore y = 1.78\,s$ OR $3.23\,s$

$\therefore$ IGOR CATCHES UP TO BRIAN AT $t = 1.78\,s$.

Hmm... WHAT HAPPENS @ $t = 3.23\,s$?

TO DETERMINE x, SUB $t = 1.78\,s$ INTO EQ^N ②.

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#3

JACK UNIFORM | BUS ACCEL.

← 15 m →

$\vec{v} = 6.0\,m/s\ [W]$

$\vec{v}_1 = 0\,m/s$

$\vec{a} = 1.0\,m/s^2\ [W]$

Same scenario as previous question!

$\Delta\vec{d} = 15m + x$

$\Delta t = t$

$\Delta\vec{d} = x$

$\Delta t = t$

OOPS $\cancel{\Delta\vec{d} = \vec{v}\Delta t}$

$\cancel{= (15+x)t}$

$\Delta\vec{d} = \vec{v}\Delta t$

$15 + x = 6t$ (1)

$\Delta\vec{d} = \vec{v}_1\Delta t + \frac{1}{2}\vec{a}\Delta t^2$

$x = 0.5t^2$ (2)

SUB (2) INTO (1)

$15 + 0.5t^2 = 6t$

$0.5t^2 - 6t + 15 = 0$

$t = \dfrac{6 \pm \sqrt{6^2 - 4(0.5)(15)}}{1.0}$

$= \dfrac{6 \pm \sqrt{6}}{1.0}$

← RESULT WILL YIELD A <u>REAL</u> # FOR TIME

∴ JACK WILL CATCH THE BUS.

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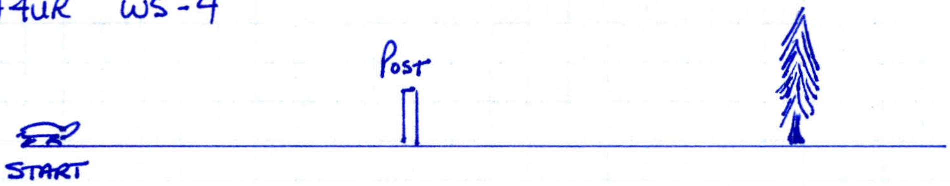
#4



UNIF.
ACCEL THROUGHOUT

$\vec{v}_1 = 0 m/s$
$\vec{a} = ?$
$\Delta\vec{d} = ?$

$1 \longrightarrow t = 10s$
$\Delta d = 10m$
$\vec{v}_2 = 1.2 m/s^2$
$\vec{a} = ?$

• WE KNOW HIS ACCEL. IS THE SAME THROUGHOUT.
EVENT #2 GIVES US ENOUGH INFO TO CALCULATE $\vec{a}$.

$$\Delta\vec{d} = \vec{v}_2\Delta t - \tfrac{1}{2}\vec{a}\,\Delta t^2$$

$$10 = 1.2(10) - \tfrac{1}{2}\vec{a}\,(10)^2$$

$$10 = 12 - 50\vec{a}$$

$$\vec{a} = 1/25\ m/s^2$$

• FOR EVENT #1, $\vec{v}_2$ AND Δt ARE UNKNOWN.
WE CAN ONCE AGAIN RELY ON EVENT #2 TO OBTAIN
$\vec{v}$ AT THE POST.

$$\Delta\vec{d} = \frac{(\vec{v}_1 + \vec{v}_2)}{2}\Delta t$$

$$10 = \frac{(\vec{v}_1 + 1.2)}{2}10$$

$\vec{v}_1 = 0.80 m/s$ ⟵ THIS IS THE SAME AS $\vec{v}_2$ IN EVENT #1

$$\therefore\ \vec{v}_2 = \vec{v}_1^{\,2} + 2\vec{a}\Delta\vec{d}$$

$$0.8^2 = 0 + 2\vec{a}\Delta\vec{d}$$

$$0.64 = 2\left(\frac{1}{25}\right)\Delta\vec{d}$$

$$\Delta\vec{d} = 8.0 m$$

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#5 $\oplus \rightarrow$

COP ACCEL. SPEEDSTER UNIF. $\vec{v}$ CATCH

$\vec{v}_1 = 0\,m/s$

$\vec{a} = 2.85\,m/s^2$

$\vec{v} = 108\,km/h = 30\,m/s$

- SEEN THIS BEFORE, HAVEN'T WE? WHAT IS MISSING FROM THE GIVEN INFO IS HOW FAR IN FRONT THE SPEEDSTER IS.

RECALL THAT IT TAKES 2.5 s FOR COP TO GET GOING.

THUS $\Delta\vec{d} = \vec{v}\Delta t$

$= 30(2.5) = 75\,m \longleftarrow$ SPEEDSTER'S HEAD START.

$\Delta\vec{d} = 75 + x$

$\Delta t = t$

$\Delta\vec{d} = x$

$\Delta\vec{d} = \vec{v}_1\Delta t + \frac{1}{2}\vec{a}\Delta t^2$

$\Delta\vec{d} = \vec{v}\Delta t$

$75 + x = 0 + \frac{1}{2}(2.85)t^2$ ①

$x = 30t$ ②

SUB ② INTO ①

$75 + 30t = 1.425t^2$

$1.425t^2 - 30t - 75 = 0$

$t = \dfrac{30 \pm \sqrt{30^2 - 4(1.425)(-75)}}{2.85}$

$= \dfrac{30 \pm \sqrt{900 + 427.5}}{2.85}$

$= \dfrac{30 \pm 36.4}{2.85}$

$\approx 23.3\,s$

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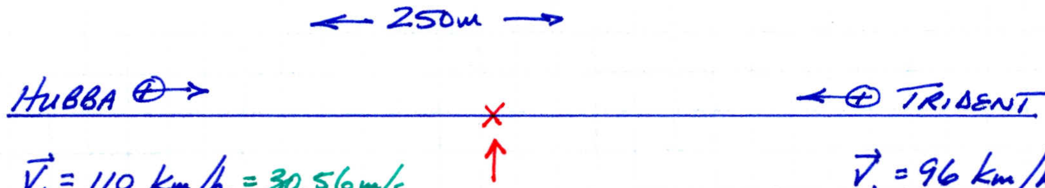
#6



$\vec{v}_1 = 110\ km/h = 30.56\ m/s$

$\vec{a} = -3.0\ m/s^2$

WILL POSSIBLY COLLIDE SOMEWHERE HERE.

$\vec{v}_1 = 96\ km/h = 26.67\ m/s$

$\vec{a} = -4.0\ m/s^2$

ASSUME BOTH TRAINS SAFELY STOP.

$\Delta\vec{d} = ?$

$\vec{v}_2^{\,2} = \vec{v}_1^{\,2} + 2\vec{a}\Delta\vec{d}$

$0 = 30.56^2 + 2(-3)\Delta\vec{d}$

$\Delta\vec{d} = 155.65m$

$\Delta\vec{d} = ?$

$\vec{v}_2^{\,2} = \vec{v}_1^{\,2} + 2\vec{a}\Delta\vec{d}$

$0 = 26.67^2 + 2(-4.0)\Delta\vec{d}$

$\Delta\vec{d} = 88.91m.$

Combining both $\Delta\vec{d} \rightarrow 244.6m.$

$\because$ DISTANCE BETWEEN THEM WAS 250m

THEN BOTH TRAINS SAFELY STOPPED WITH 0.40m TO SPARE.

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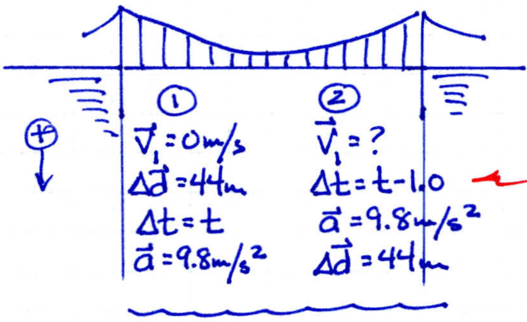
#7



STONE ② COVERS SAME DISTANCE BUT HAS TO DO SO IN 1.0s LESS.

STONE ①

$$\Delta\vec{d} = \vec{v}_1\Delta t + \tfrac{1}{2}\vec{a}\Delta t^2$$

$$44 = 0 + 4.9t^2$$

$$t \doteq 3.0\,s$$

SUB INTO

STONE ②

$$\Delta\vec{d} = \vec{v}_1\Delta t + \tfrac{1}{2}\vec{a}\Delta t^2$$

$$44 = \vec{v}_1(t-1) + 4.9(t-1)^2$$

$$44 = \vec{v}_1(2) + 4.9(2)^2$$

$$44 = 2\vec{v}_1 + 19.6$$

$$\vec{v}_1 = 12.2\,m/s$$

#8

STONE

$\vec{v}_1 = 0\,m/s$

$\vec{a} = 9.8\,m/s^2$

$\Delta\vec{d} = x$

$\Delta t = t$

?

SOUND

$\vec{v}_1 = 330\,m/s$

$\Delta\vec{d} = x$

$\Delta t = 3.0 - t$

SOUND TRAVELS UP SAME DISTANCE ROCK FELL DOWN

IT TOOK TIME t FOR STONE TO STRIKE H_2O

SOUND WAS HEARD 3.0s AFTER STONE WAS RELEASED
∴ TIME FOR SOUND TO TRAVEL UP WOULD BE 3.0 − (TIME FOR STONE TO FALL).

$$\Delta\vec{d} = \vec{v}_1\Delta t + \tfrac{1}{2}\vec{a}\Delta t^2 \qquad \Delta\vec{d} = \vec{v}_1\Delta t$$

$$x = 4.9t^2 \;① \qquad x = 330(3-t) \;②$$

EQUATE ① + ②

$$t = 2.877\,s$$

$$\Delta\vec{d} = 40.6\,m$$

YOU SHOULD BE ABLE TO TAKE IT FROM HERE.